PART 2

FOUNDATIONS AND PAVEMENTS

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I. PURPOSE, CRITERIA, AND FILE FORMAT:

A. Purpose: The purpose of this Guidance Package is to outline the requirements for geotechnical investigation, testing, and design (i.e., foundations, earthwork, and pavements) services required in the development of Government Contract Documents for the U.S. Army Corps of Engineers, Baltimore District, Geotechnical & Water Resources (GWR) Branch of the Engineering Division, also referenced to herein as the Government.

B. Criteria: Technical Instructions TI 800-01 from CEMP-E, dated 20 Jul 1998 (and all current changes), are to be used replacing Architect Engineering Instructions (AEI) for all U.S. Corps of Engineers designs except medical facilities which are governed by AEI, Medical Design Standards. These TI are available at the U.S. Army Corps of Engineers TECHINFO web address: http://www.hnd.usace.army.mil/techinfo/index.htm.

C. File Format: File attachments are in PDF (Adobe Acrobat File)format.

II. RESPONSIBILITIES:

A. General: The actual extent and type of professional services required by the AE for the project shall be as defined in the project Scope of Work (SOW) as provided to the AE by the Government (i.e., Design Team Leader). However, two general types of services are typically required, namely: (i) geotechnical investigation and testing services, and (ii) geotechnical design (i.e., foundation, earthwork, and pavement) services. The aforementioned two services can be provided exclusively by the Government, exclusively by the AE, or in various combinations. General responsibilities are described hereinafter:

B. Geotechnical Services Provided by the Government: Unless otherwise specified in the Scope of Work, the Government shall be fully responsible to perform both the geotechnical investigation and testing and geotechnical design for the project. The F&P Section (i.e., the Foundations & Pavements Section of the Geotechnical & Water Resources Branch of Engineering Division) will fully coordinate geotechnical aspects of the project for the Government. The required coordination and division of responsibilities between the AE and the Government are as follows:

1. Government Responsibilities:

a. Subsurface Exploration and Laboratory Testing: The subsurface investigation and laboratory testing programs will be prepared and performed by the Government. These programs will exclude soil resistivity and topsoil testing unless such tests are specifically requested by the AE.

b. Geotechnical Foundation Design Analysis (Geotechnical Report): The geotechnical report shall be performed by the Government to include the following:

1. Foundation design recommendations (exclusive of structural design).

2. Allowable soil and/or rock bearing pressure and/or side shear values for use in the design of deep foundations.

3. Pavement thickness design (rigid and flexible). The AE will perform all other pavement design aspects (geometric layout, vertical and horizontal curves, pavement subdrain layout and design etc.).

4. Earthwork recommendations.

c. Earthwork and Pavement Specifications:

1. The Government will edit earthwork and pavement guide specifications and coordinate with the AE where his input is required.

2. The Government will prepare the final specifications and will forward to the AE in hard copy and electronic format (*.DOC (WORD format) or as specified in the SOW).

3. The AE will have responsibility for concrete specifications, but the Government will prepare an insert to that section to cover any required rigid pavement work. This insert will be provided in both hard copy and electronic format (*.DOC (WORD format) or as specified in the SOW).

d. Drawings:

1. The Government will prepare drawing plate(s) containing the subsurface exploration logs and notes in AUTOCAD™. The AE will provide a site layout and grading plan for the Government, in electronic format (*.DWG or as specified in the SOW) to lay out the final boring locations. The AE will incorporate the prepared boring logs and their respective locations into the final contract drawings.

2. The Government will prepare the final drawings for the following details and forward them to the AE in both hard copy and electronic format (*.DWG or as specified in the SOW) (Note: These details will also be available in an electronic format for distribution to the AE):

a. Flexible and rigid pavement sections.

b. Pavement transition sections.

c. Rigid pavement joint layout and details.

d. Pavement subdrain details (layout to be performed by the AE based on general guidance provided by the Government.

e. Subgrade stabilization.

f. Structural fill details

3. All title blocks shall be done by the AE.

e. Review and Coordination: The Government will perform its normal review functions and will coordinate its design responsibilities with those for the AE.

f. Estimates: All construction cost estimates and quantity calculations will be performed by the AE. The Government will provide necessary sketches as previously discussed.

g. Engineering During Construction: The Government will review those submittals required in its specification sections; will supervise and evaluate any required foundation or pavement field tests, and will make site visits as required to insure implementation of the design or to perform remedial design during construction.

2. Design Support Provided by AE:

a. Survey Support for Subsurface Exploration: The Government will prepare a boring location plan on the site plan provided by the AE. The AE will provide a licensed geodetic survey crew to lay out the boring locations in the field and furnish the Government with the top of hole elevations at each drill hole location. A third-order horizontal and vertical survey shall be accomplished.

b. Concept Design: The AE will furnish the Government a site plan as soon after design start as feasible showing a single-line location of the proposed structure, paving, and underground utilities. A brief description of the structure (i.e., finished floor elevations, number of stories, depth of basement, approximate foundation loads, etc.) and the proposed earthwork and paving requirements must accompany this site plan. All estimates and quantity takeoffs shall be the AE's responsibility. In addition, the AE shall be responsible for the preparation of all drawing title blocks and the incorporation into the concept drawings of all sketches and details provided by the Government.

c. Final Design: The AE will prepare and forward to the Government a final location plan for the structure, paving, and underground utilities. A location plan for the structure must include elevations and the locations and loadings of foundations. The location plan should show existing and proposed grades. All construction cost estimates and quantity calculations shall be performed by the AE. In addition, the AE shall be responsible for the preparation of all drawing title blocks and the incorporation into the final drawings of all sketches and details provided by the Government.

d. Coordination: The AE shall be responsible for coordination and transmittal of design data between the Government and related design disciplines (i.e., architects, and structural and civil

engineers), and the incorporation of the geotechnical report prepared by the Government into the concept and final project design analyses.

C. Geotechnical Design Provided by the AE: If specified in the project Scope of Work, the AE shall be fully responsible to perform the geotechnical design (i.e., foundation design recommendations, earthwork recommendations, and pavement design) for the project. However, geotechnical investigation and testing services may be provided by either the AE or the Government, as specified in the project Scope of Work. The required coordination and division of responsibilities between the AE and the Government are as follows:

1. Architect-Engineer (AE) Responsibilities: The AE is responsible for preparation and accomplishment of the following:

a. Subsurface exploration program, if specified in the project Scope of Work (see Section III).

b. Soil and rock laboratory testing program, if specified in the project Scope of Work (see Section III).

c. Geotechnical Foundation Design Analysis (AKA Geotechnical Report). The geotechnical report shall be prepared by or under the supervision of a registered professional engineer qualified in geotechnical engineering and submitted under his seal and signature (see Section IV).

d. Pavement design analysis (thickness design). The report shall be prepared by or under the supervision of a registered professional engineer qualified in geotechnical engineering and submitted under his seal and signature (see Section IV).

e. Earthwork, foundation, and pavement specifications, drawing details, and estimates (see Sections V and VI).

f. Estimates: All construction cost estimates and quantity calculations shall be performed by the AE. The AE will provide necessary sketches as previously discussed.

g. Site Visit: The AE is also expected to visit the site to determine by all means available, including examining data in the Facilities Engineer's possession, where and to what extent unsuitable material can be expected.

2. Government Responsibilities:

a. Subsurface Investigation and Testing Performed by the Government: The Government shall be fully responsible to perform the subsurface investigation and geotechnical testing program. The Government will provide the AE with all subsurface investigation data and all requested laboratory geotechnical testing as hereinafter stated.

b. Subsurface Investigation and Testing Performed by the AE: The AE shall be fully responsible to perform the subsurface investigation and geotechnical testing program. This work shall be done under the supervision of a qualified and experienced geotechnical engineer within the AE firm or by a hired geotechnical consultant using experienced, qualified, and licensed drillers and laboratory technicians, as hereinafter specified.

III. SUBSURFACE INVESTIGATIONS:

A. General: An adequate subsurface investigation program addresses soil, rock, and groundwater conditions in support of final site evaluations, design, construction activities. The information gained from the subsurface investigation program is required for to provide data for a safe and economical geotechnical design; to allow for the preparation of contract and bid documents including a construction cost estimate; and to assist the contractor in analyzing the feasibility, costs, procedures, and equipment needed for construction.

1. Submission of Investigation Program: The AE will furnish the Government his proposed subsurface investigation program as soon as possible. The program must include a boring location plan with the required depth and sampling interval of each boring. Each boring location should be uniquely labeled with a letter symbol indicating the type of boring and a boring number (e.g., DH-3; AB-7; AB-9; TP-10).

2. Subsurface Investigations: Regardless of who performs the subsurface investigation, all subsurface investigation and testing programs must be submitted to the Government for review and approval prior to their commencement and must meet all requirements stipulated herein. Where the subsurface investigation is performed by the Government, preliminary drill logs made by field personnel shall be furnished the AE as they become available. Similarly, preliminary drill logs shall also be furnished to the Government as they become available when the AE performs the the subsurface investigation.

B. Methods of Investigation:

1. General: Standard and accepted methods of subsurface investigation shall be used to obtain subsurface data, as discussed in ASTM D-420. The extent of the investigation shall be tailored to meet the needs of each project. Generally, investigations shall be deep enough to identify all strata that might be significantly affected by the proposed use of the site and to develop the geotechnical data required. Borings for structures shall extend below the level of significant stress influence as determined by a subsurface stress analysis. Conventional methods of subsurface investigation are as follows.

2. Drive Sample Borings (DH): Drive sample borings utilize Standard Penetration Test (SPT) procedures by driving a split-barrel sampler to obtain a representative soil sample and a measure of the resistance of the soil to penetration of the sampler. Drilling and sampling methods shall be in compliance with ASTM D-1586, unless otherwise directed. Unless otherwise directed, the penetration interval is normally 1 meter (2-1/2 feet), but may vary with drill hole depth; samples are taken every 1 meter (2-1/2 feet) or for each change of strata. Use of pocket penetrometer to determine the shear strength is recommended for cohesive soils prior to removing the sample from the split spoon. When SPT refusal (100 blows or greater with less than 50 mm (2 inches) of penetration) is encountered, it may be necessary to further advance the boring using diamond core drilling methods.

3. Auger Borings (AB): Power auger borings, 100mm to 150mm (4 to 6 inches) in diameter, are drilled in proposed pavement areas, borrow areas, and along utility lines for the purpose of classifying shallow subsurface materials and determining the depth to

groundwater and rock. Soil investigations and sampling by auger borings shall be in compliance with ASTM D-1452, unless otherwise directed.

4. Test Pits (TP): Test pit dimensions are normally 1 meter by 1 meter by 0.5 meter (3 feet by 3 feet by 1.5 feet) and excavated in areas for proposed pavements to obtain undisturbed CBR samples. Deeper test pits are used to examine strata, to sample soils in-situ, to determine thickness of topsoil, and to determine depth to groundwater. If possible, test pits should be located in areas where existing grades are near final grades. Undisturbed CBR samples are obtained at the proposed subgrade elevation for laboratory determination of in-situ conditions using a 150 mm (6-inch) diameter commercially obtained CBR cylinder. Disturbed (remolded) samples include large bag samples (totaling a minimum of 160 kilograms (min 350 lbs)) and one jar sample for remolded CBR testing. The number and depths of test pits will depend upon the area involved. Test trenches are used in very heterogeneous deposits (i.e., rubble fills) where borings are either meaningless nor feasible. Test pits and trenches are either hand excavated if shallow or mechanically excavated if deep.

5. Plate Bearing Tests: These tests are performed for proposed rigid pavement areas of considerable size (i.e., 1000 cubic meters(1000 yards)). For small areas, the typical K values given in TM 5-822-5 or TM 5-809-12 are sufficient to determine subgrade strength.

6. Undisturbed Sampling: Thin-walled metal tubes (AKA Shelby Tubes) shall be utilized to recover relatively undisturbed soil samples suitable for laboratory testing of engineering properties. Thin-walled tubes shall be obtained from a commercial source and shall be 3-inch O.D. by 30-inch in length, unless otherwise specified. Thin-walled (undisturbed) samples are required in soft, cohesive soils. Undisturbed sampling by thin-walled sampling shall be in compliance with ASTM D-1587, unless otherwise directed.

7. Core Drilling: Samples that are too hard to obtain utilizing soil sampling methods shall be obtained using diamond core drilling methods. Unless otherwise directed a double-tube, swivel type, NX, NQ or larger size design diamond core barrel shall be used. Diamond core drilling shall be in compliance with ASTM D-2113, unless otherwise directed.

8. Transportation and Storage of Samples: Preserving and transportation of soil samples shall be accordance with ASTM D-4220. Preserving and transportation of rock core samples shall be accordance with ASTM D-5079. Labeling of sample containers shall in accordance with Appendix III-7. All soil and rock samples are stored by the Government throughout construction of each project. All samples obtained from AE investigation programs shall be retained, transported, and unloaded at the AE’s expense at the Baltimore District Soils Laboratory at Fort McHenry Yard, 2603 Leahy Street, Baltimore, MD 21230, phone (410) 962-4045, unless otherwise directed. The Design Team Leader should be contacted a minimum of 3 working days prior to delivery of samples.

9. Groundwater: The scope of the groundwater investigation shall be tailored to the project. Minimally, the subsurface investigation program obtain data on groundwater elevations and profiles, fluctuations, existence and location of perched water tables, depths to water bearing zones, direction of flow, and estimates quantities. Results from the investigation shall be used for dewatering

and seepage control systems design. Groundwater readings are taken when encountered, on completion of drilling, 24 hours after drilling of a hole has been completed, and daily while the boring remains open. In unusual circumstances (e.g., deep excavation with high groundwater), observation wells or piezometers shall be installed to monitor groundwater levels. Installed wells shall be in accordance with EM 1110-2-1908 or equivalent.

10. Geophysical: If applicable, geophysical techniques may be used to supplement borehole data and to interpolate between borings. Seismic, ground penetrating radar, electrical resistivity, or other geophysical methods may be useful in delineating subsurface features and conditions. Geophysical methods are particularly useful in te delineation of faults, fractures, cavities, voids, and bedrock irregularities; including determine depth to, and rippability of, bedrock.

11. Terminology: Only standard and accepted terminology, as discussed in ASTM D-653, shall be used in all records and reports.

12. Records and Reports: Description and identification of Soils (visual-manual procedures) shall be in accordance with ASTM D-2488. The Geotechnical Report shall include all applicable field records, laboratory test results, and graphical representations. Interpretations and recommendations for design parameters shall be made only by professional engineers and geologists specializing in geotechnical engineering.

C. Laboratory Testing of Samples:

1. General: A comprehensive laboratory geotechnical testing program shall be performed for both materials classification and engineering property testing. All laboratory geotechnical testing programs must be submitted to the Government for review and approval prior to their commencement.

a. Laboratory Testing Performed by the Government: Unless otherwise directed, all laboratory geotechnical testing shall be performed by the Government (Baltimore District Soils Laboratory). Laboratory test results will be furnished the AE as they become available.

b. Laboratory Testing Performed by AE: Where the AE utilizes a private, commercial geotechnical testing laboratory, the laboratory must have been inspected and evaluated for the specific testing services in accordance with ER 1110-1-8100 prior to performing any testing. Documentation shall be provide to the Government upon request. In accordance with ER 1110-1-261, the AE shall develop a QA plan to ensure the validity of the testing results. Personnel engaged in the testing of soil and rock shall be certified in accordance with ASTM D-5255. Agencies engaged in the testing of soil and rock used in engineering design shall be in compliance with ASTM D-3740. Documentation shall be provided to the Government upon request. The AE is required to contact the Government upon receipt of preliminary logs to discuss the laboratory geotechnical testing program. When the Baltimore District does not perform the laboratory testing, test results shall be furnished to the Government as they become available.

2. Soils: The following laboratory tests are normally performed:

a. Classification: Soils are classified according to the Unified Soil Classification System described in ASTM D-2487.

b. Mechanical Hydrometer Analysis, Water Content, Specific Weights And Atterberg Limits: Mechanical hydrometer analysis (ASTM D-422), water content (ASTM D-2216), specific weights and Atterberg limits (ASTM D-4318) are performed on typical soil samples in sufficient number to classify all materials explored.

c. Unconfined Compression And Consolidation Tests: Unconfined compression (ASTM D-2166) and consolidation tests (ASTM D-2435) are performed on representative samples of undisturbed cohesive soils taken within the zone of foundation influence and as considered necessary for a complete foundation analysis. Samples not necessary for testing are opened and classified. Density tests are conducted when required.

d. Shear tests: Direct or triaxial shear tests are performed as required. Due to their expense, triaxial tests are only performed when the nature and scope of the project demand this information.

e. CBR Tests: Undisturbed CBR tests are performed on all samples to determine in-situ soil strength, density, and water content. Moisture-density relationships are established and remolded CBR tests are performed on representative samples for comparison. A 15-point remolded CBR test is normally used in accordance with ASTM D-1883.

f. Other: All other geotechnical soil testing that is required and not specified herein, shall be accomplished in accordance with accepted industry standards and practices, unless otherwise approved by the Government.

3. Rock:

a. Logging: Rock cores shall be described and classified by an experienced engineering geologist in accordance with EM 1110-1-1804 and ER 1110-1-1802; “A Guide to Core Logging for Rock Engineering,” Core Logging Committee, South African Section, AEG, Proceedings of the Symposium on Exploration for Rock Engineering, Johannesburg, November 1976; the Engineering Geology Field Manual, USDI-BR; or Government approved equivalent. Rock colors shall be described in accordance with the Rock-Color Chart, Geological Society of America.

b. Unconfined Compressive Strength: Unconfined compressive strength testing of intact rock cores shall be in accordance with ASTM D-2938. Elastic moduli testing of intact rock core samples shall be performed in accordance with ASTM D-3148.

c. Other: All other geotechnical rock testing that is required and not specified herein, shall be accomplished in accordance with accepted industry standards and practices, unless otherwise approved by the Government.

D. Presentation of Data in Contract Documents: When subsurface investigation is performed by the Government, final logs will be prepared by the Government and furnished to the AE. When subsurface

investigation is performed by the AE, final logs shall be prepared by the AE and submitted to Government for review and approval prior to being incorporated into the contract drawings. Soil and rock information obtained from field logs, laboratory tests, and geologist notes and logs should be presented on the contract drawings in the form of final borings logs and explanatory notes. It is particularly important that complete subsurface information, including but not limited to: dates, elevations, depths to rock, depths to groundwater, drilling equipment used, and the presence of unsatisfactory materials, etc., be presented to the contractor for bidding purposes. All information obtained by the Government as must appear in the contract drawings to protect the Government from potential claims. The Government has an obligation to disclose the geotechnical information "fully and accurately."

1. Duty to Disclose: If the Government possess information about geotechnical conditions which it knows the bidder or contractor does not possess or have access to, and which is relevant to the cost or method of performance, the Government is required to disclose such information in the contract documents. The Government has an implied duty to help, not hinder, contractor performance and is legally obligated to provide contractors with special knowledge in formulating their cost estimate and bid. This duty to disclose covers all material information about the site that the Government possess, even if not discovered specifically in the geotechnical investigation or design process for that particular project. However, the Government does not have a duty to disclose judgments and conclusions which it draws from factual data, as opposed to the raw factual information itself. Nor does the Government have an obligation to disclose technical information which the contractor has equal access through its own experiences, through cursory inspection, or through industry or public domain data.

2. "Differing Site Conditions" Clause: Federal construction contracts are required to contain the "Differing Site Conditions" Contract Clause. Accordingly, the Government assumes the risk of material differences between the actual conditions and those indicated as a result of the geotechnical site investigation, which is disclosed in the contact documents.

3. Disclaimers: With the 'Differing Site Conditions" Contract Clause, a disclaimer on subsurface geotechnical data presented in the contract documents is largely ineffective as a matter of law. Thus, a general disclaimer of the Government's responsibility for geotechnical data is virtually not enforceable to overcome the "Differing Site Conditions" Contract Clause. Legal conflicts between disclaimers and the "Differing Site Conditions" Contract Clause have been legally resolved in favor of the Clause.

IV. DESIGN ANALYSES:

A. Geotechnical Design Analysis:

1. References: A geotechnical design analysis (Geotechnical Report) is required to show that the type of foundation selected is the most feasible one capable of supporting the structure. The analysis must include a narrative describing the design approach and all estimates, all references used and assumptions made, as well as soil bearing, rock end bearing and/or side shear, and settlement calculations in accordance with the guidelines and general requirements of: TM

5-818-1 "Procedures for Foundation Design of Buildings and Other Structures (except Hydraulic Structures)"; EM 1110-1-1905 "Bearing Capacity of Soils;" EM 1110-1-1904 "Settlement Analysis;" and EM 1110-2-2906 "Design of Pile Foundations." In lieu of these manuals, detailed analysis may follow the outline and/or approach covered in any recognized soil mechanics, rock mechanics and/or foundation design text.

2. Concept Design: At the concept design submission, indicate the foundation type which will be used for the structure(s) involved. Specifically indicate whether a conventional (spread footing), mat type, pile or caisson foundation will be used. Approval at this point does not mean that a change cannot be made at a more advanced stage of the design if another system is considered more feasible. However, this office should be notified as soon as any change is under consideration.

3. Final Design: The final geotechnical foundation design analysis should be submitted at the 50% stage of design. The choice of a specific deep foundation system should be justified at this time by an economic comparison between shallow foundation systems, drilled shafts, and several different pile types.

a. Soil Foundations: Except for nominal foundation loads, the use of the Standard Penetration Test (blow counts or N values) will not be considered satisfactory for the design of foundations on fine-grained soils (silts and clays). Soil strength and consolidation characteristics for fine-grained soils shall be based on laboratory tests performed on undisturbed samples. Detailed design calculations, along with an explicit discussion of assumptions utilized, shall be provided in the Geotechnical Report.

b. Rock Foundations: Except for nominal foundation loads, allowable rock bearing pressures shall be based upon: (i) building codes, (ii) empirical rules, (iii) rational methods based upon theoretical analysis, or (iv) full scale load tests. Documentation and detailed discussion of selected bearing pressures shall be provided by the AE. The design method used shall be based upon accepted standard practices and rational load-transfer mechanisms and shall be appropriate for the subsurface conditions encountered. Detailed design (i.e., stress and settlement) calculations, along with an explicit discussion of assumptions utilized, including references and documentation, shall be provided in the Geotechnical Report. Additional technical criteria and Guidance may be found in EM 1110-1-2908.

1. Excavatability of Rock. If rock excavation is required, a discussion of rock excavatability shall also be proved. Technical criteria on rippability of rock may be found in ETL 1110-2-282; ASTM STP-984 (1988); Pettifer, G.S. and Fookes, P.G. (1994); the Caterpillar™ Performance Handbook; or suitable equivalent.

B. Pavement Design Analysis (Thickness Design):

1. References: A pavement thickness design analysis required in accordance with TM's 5-822-2, 5-822-5, and 5-809-12, for vehicular traffic and TM's 5-825-1, 5-825-2, 5-825-2-1, 5-825-3 and 5-825-3-1 for airfield pavements. This analysis must satisfy both strength and frost criteria and should include calculations (see Appendix I for design forms) for the Limited Subgrade Frost Penetration Method and Reduced Subgrade Strength Method. When the frost criteria controls the pavement design, the Using Agency should be contacted to

determine if experience allows a pavement section less than required by the frost criteria. This determination should be reflected in the design analysis. In no case should the pavement section be thinner than required by the strength criteria. Interior concrete floor slabs-on-grade subject to vehicular traffic should be designed as rigid (concrete) pavements in accordance with the above references, except that a frost design will not be necessary when these interior areas are heated.

2. Traffic Data: Traffic data can be obtained from the Using Agency upon request. A typical traffic request for vehicular pavements is provided in Appendix I.

3. Drainage of the Base and Subbase: Draining of the base and subbase is also a prime consideration in the design. The analysis should include a narrative, and calculations as necessary, concerning positive subdrainage. Materials used must be locally available. Discuss the pros and cons of: a system equivalent to that designed by the local state when subbase course materials meeting state specification are used in the pavement structure; longitudinal and/or transverse perforated/slotted pipes; and a highly permeable blanket or trench system. If locally available materials satisfy Corps of Engineers subbase standards (i.e., less than 8% passing the #200 sieve and less than 3% smaller than the 0.02 mm size), design should be in accordance with TM's 5-820-2 and 3, EM 1110-3-435, and other recognized texts on drainage design.

C. Outline for Design Analysis:

1. General: The design analysis should be complete, with supporting data covering the various items shown in the Outline for Design Analysis below. The design analysis will be influenced by the scope of the project. The analysis is required primarily to substantiate the design and provide reviewing agencies with complete design information including discussion of investigations, laboratory test results, and the basis for design values chosen. The test data to be included as figures can be prints of sheets furnished to the AE. These should be kept to a minimum but sufficient to give complete representative information. Compaction and CBR test sheets, of which there are usually only a few, should be included. Water contents, unit weights, unconfined compressive strengths, and similar data can be tabulated with references to samples. When consolidation test data are used in the design, these test sheets should be included. Figures showing locations of borings and boring logs should also be included as they are archived for future reference.

2. Outline: This outline is intended to convey to the AE the minimum information and data necessary for the design analysis.

a. General Site Information: General site conditions such as the following:

1. Tillable ground or wooded areas.

2. Flat, rolling, or hilly sites.

3. Natural ground or fill.

4. Nearness to streams, bay, marshes, etc.

5. Other physical surface features.

b. Subsurface Investigation:

1. For structures - should include, but not be limited to, the following:

a. Number and type of borings.

b. Refer to locations on enclosed figures/drawings.

c. Equipment and/or sampling devices used.

d. Discussion of soils encountered in borings.

e. Discussion of rock or refusal depths, if encountered.

f. Groundwater conditions; mention time of year.

2. For pavements.

a. Number and type of explorations.

b. Discussion of soils and conditions at subgrade elevations.

c. Groundwater conditions.

d. Field CBR and/or Plate Bearing Tests.

c. Laboratory Testing: To include, but not limited to, the following:

1. Visual classification - according to what system?

2. Number and types of tests.

3. Discuss purpose of tests.

4. Discuss results of tests - include unusual results and effect on design.

5. Submit all laboratory test results.

d. Foundation Design:

1. Discuss foundation materials.

2. Discuss method or procedure of foundation analysis with reference to text book or other source.

3. If soil supported foundation, design based on soil type: clay, silt, sand or gravel.

a. If clay or silt, discuss factors on which soil bearing was based:

1. Unconfined compression test, direct shear test, or triaxial shear test.

2. Consolidation (settlement) test.

b. If sand or gravel, discuss factors on which soil bearing was based:

1. Standard penetration test (blow count data).

2. Effect of groundwater.

3. Other test results.

4. If foundation is supported on rock, design shall be based on, but not limited to, the following considerations:

a. Geology.

b. Rock mass/material properties.

c. Groundwater conditions.

d. Structural loads.

e. Site conditions (i.e., drillablity of formations, accessible depths, surface access, presence of cobbles and boulders, etc.).

f. Local practices and availability of equipment.

5. Unusual factors should be considered in the design; such as:

a. Fill areas.

b. Building foundation partially on soil and partially on rock, or partially on in-situ soil and partially on fill.

c. Dewatering.

6. Allowable soil and/or rock bearing values - summarize factors leading to determination of the allowable soil and/or rock bearing value.

7. Discuss type or types of foundations considered and reasons for final selection.

e. Design of pavements - should include the following information:

1. Type soil in subgrade.

2. Groundwater influence.

3. CBR or K value from laboratory tests or tabular values.

4. Traffic information - composition and volume (quote directive or Using Service).

5. Give assumed flexural strength of concrete where pertinent with backup data such as:

a. Aggregates.

b. Service records.

c. Results of previous tests.

V. GUIDE SPECIFICATIONS:

A. Changes: The Government requires that several changes be made to the standard Corps of Engineers guide specifications (CEGS). These changes have already been made on a locally edited versions of these guide specifications and are available in electronic format (*.DOC) which can be furnished to the AE. These changes should be used with judgment, and some will require editing to meet specific project requirements.

B. State Requirements for Bituminous Concrete: When bituminous concrete is required for paving, it is acceptable to use state specifications rather than guide specification CEGS 02551. Specification sections which make reference to the applicable paragraphs of the state specifications have been prepared by this office and are available upon request in electronic format (*.DOC). The following information should be furnished this office when requesting the use of state specifications:

1. Quantity of bituminous concrete to be used in tons.

2. Traffic class, category and tire pressure assumed for design.

3. Thickness of surface and/or binder course to be used.

This information is required so that permission can be obtained from higher authority to use state specifications.

C. Drilled Pier (Caisson) Guide Specification: Although a standard CEGS for drilled piers does exist, a more comprehensive guide specification for this item of construction for this geographical area has been prepared by this office and is available upon request in electronic format (*.DOC).

D. Bid Items: Generally, geotechnical features for all projects will be bid on a lump sum basis. The only exception will be piling and drilled piers (caissons)and in some cases where subgrade stabilization is required but the extent is not known. These items will be bid on a unit price basis.

VI. PLANS:

A. Standard Details: Sample standard details used by this office for preparation of plans are included in Appendix II. Many more details are available but are too numerous to include. These details should be used where required and are available in electronic format (*.DWG).

B. Bearing Pressures: Where applicable, the allowable soil or rock bearing pressure should be shown on the plans. This pressure should be indicated in such a manner that it is understood that the pressure is the design (allowable) pressure used in sizing the foundations and that this pressure is not the ultimate pressure which the soil or rock can withstand.

C. Physical Features: Show all physical surface features of the site; including, but not limited to: rock outcrops, wet areas (swamps, springs, marshes, streams, etc.), landfills, geological features (sinkholes, solution susceptible materials, subsidence, fills, faults, landforms, slopes, etc.), cultural features (mines, powerlines, pipelines, access routes, wells, quarries, ground conditions, etc.) existing pavement conditions, etc. This information can influence the design, construction, and bidder's estimates of the earthwork, foundations, and paving features of the project.

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24. ER 1110-1-8100, "Laboratory Investigations and Materials Testing."

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26. ER 1110-2-1806, "Earthquake Design and Analysis for Corps of Engineer Projects."

27. EM 1110-1-1802 "Geophysical Explorations."

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APPENDIX I

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APPENDIX II

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APPENDIX III

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Note: The examples in this appendix are intended to illustrate the pre-sentational format for subsurface exploration information.